

Live Shipping of Florida's Spiny Lobster

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FLORIDA's spiny lobster, *Panulirus argus*, is ordinarily cooked, packaged, and frozen before shipment. The consumer, who must thaw and reheat the lobster, often serves an overcooked product of reduced quality. Live shipment of spiny lobsters can increase consumer acceptance by enhancing the product's appearance and palatability.

Large quantities of northern lobster, *Homarus americanus*, are shipped alive under cool, moist conditions (Anon., 1948). Live African rock lobsters, *Jasus lalandei*, are air shipped from South Africa to Europe (Harvey, 1962). Harvey reports 100 per cent survival for 24 hours and about 50 per cent survival after 44 hours when the temperature inside of the carton had been lowered to 3.9 C (39 F) and allowed to warm gradually to ambient air temperature of 18.9 C (66 F). These procedures have been extremely successful and provide a product of highest quality. Other aquatic animals, including fishes and shrimp for aquaria and shrimp for food are shipped alive (Idyll, 1965; Futch and Woodburn, 1967). Barnett et al. (1969) report success in air shipment of live dungeness crabs, *Cancer magister*, with reduced temperatures, 1.7 C (35 F) to 10.0 C (50 F), and relative humidity of 80-100 per cent. Increased costs of handling are usually offset by an increased demand and a higher retail price. Consequently, the Marine Laboratory initiated these studies to determine the best conditions for shipping live Florida lobsters.

METHODS AND MATERIALS

Packing Material Tests. The first experiment was designed to test the effectiveness of various materials under different temperature conditions. Adult lobsters were obtained from commercial sources and maintained for at least one day to ascertain their good health. A dozen live lobsters were then packaged four to a shipping carton, using seawater-wetted burlap bags. Another dozen were packed in seawater-wetted sargassum weed, and a third dozen in seawater-wetted polyurethane foam. A fourth dozen,

similarly handled but with no packing material, served as a control. Cartons packed under each method were held at 4.4 C (40 F), 10.0 C (50 F), and at ambient temperature. The animals were examined twice daily for three days (Table 1). The experiments were replicated to verify results (Table 2). A third series of packing tests, using burlap at ambient temperature, were carried out on groups of 10, 12, and 18 lobsters for 36 hours (Table 3).

Shipment in water-filled plastic-lined cartons is considered inadvisable because of prohibitive shipping costs, as well as the danger of puncture and subsequent water loss. Although Idyll (1965) reported successful shipping of live shrimp in sawdust, this method was not tested because a suitable supply was not available.

Spray Unit Tests. Previous experiments using a seawater spray over live lobsters had indicated the possibility of prolonging survival and therefore a small self-contained, portable spray system was tested. Such a unit was placed in the back of a pickup truck (Fig. 1). The spray tank (4'×2'×16" deep) contained eight lobster holding trays (16"×16"×4" deep) and was covered by a lid designed to allow air to circulate while at the same time retaining the saltwater spray. The tank and trays were made to hold approximately 3/4" of seawater, since it had been observed previously that the lobsters died unless some water was retained in the trays. Because ultraviolet light effectively sterilizes water (Anon., 1965; Nagy, 1965; Torpey et al., 1966) a sterilizing tank was constructed using two 30-watt ultraviolet tubes, and was located between the spray tank and a water storage tank. Seawater was pumped by a "Teel" 115 volt recirculating pump, Model 1P618, through a filter made of plastic pipe packed with 20 mesh per inch nylon webbing. All pipe and the small spray heads were nontoxic plastic. After spraying into the holding tank, the water returned by gravity through the sterilization chamber to the storage tank. While on the truck electricity for the pump and ultraviolet lights was provided by a "Topaz Powermaker," Model 310-B-12, which converted the 12 volt DC to the necessary 115 volt AC.

The first survival experiment was conducted with the portable spray unit assembled in the air-conditioned laboratory, where temperatures ranged from a low of 24.4 C (76 F) to a high of 31.1 C (88 F). Forty subadult lobsters, 34 that had been in a tank at the House of Refuge Museum for a month or more and six that had

TABLE 1
 Number of lobsters surviving in various packing media and selected temperatures. (Packing Test No. 1)

Date	2-23-67 9:00 AM	2-23-67 4:00 PM	2-24-67 8:00 AM	2-24-67 4:00 PM	2-25-67 9:00 AM	2-25-67 5:00 PM	2-26-67 7:30 AM
Time of check							
Hours (rounded)		7	23	31	48	56	71
4.4 C (40 F)							
No packing	4	0					
Burlap	4	0					
Polyurethane foam	4	4	0				
Sargassum	4	4	0				
10.0 C (50 F)							
No packing	4	3	2	0			
Burlap	4	4	2	2	2	1	1
Polyurethane foam	4	4	4	4	1	2	1
Sargassum	4	4	4	4	4	4	3
7.2 C (45 F)—21.1 C (70 F ambient temp.)							
No packing	4	4	4	3	1	1	0
Burlap	4	4	4	4	4	4	4
Polyurethane foam	4	4	4	4	4	3	2
Sargassum	4	4	4	4	3	2	1

TABLE 2
 Number of lobsters surviving in various packing media and selected temperatures. (Packing Test No. 2)

Date	3-10-67 10:00 AM	3-16-67 4:00 PM	3-17-67 8:45 AM	3-17-67 4:00 PM	3-18-67 8:30 AM	3-18-67 4:30 PM
Time of Check Hours (rounded)		6	23	30	47	55
4.4 C (40 F)						
No packing	4	0				
Burlap	4	1	1	0		
Polyurethane foam	4	2	0			
Sargassum	3	3	3	1	0	
10.0 C (50 F)						
No packing	4	3	2	1	0	
Burlap	4	4	1	1	0	
Polyurethane foam	4	4	3	3	1	0
Sargassum	4	4	2	1	0	
18.3 C (65 F)—29.4 C (85 F ambient temp.)						
No packing	4	4	2	0		
Burlap	4	4	3	3	0	
Polyurethane foam	4	2	2	2	1	0
Sargassum	4	4	4	4	2	0

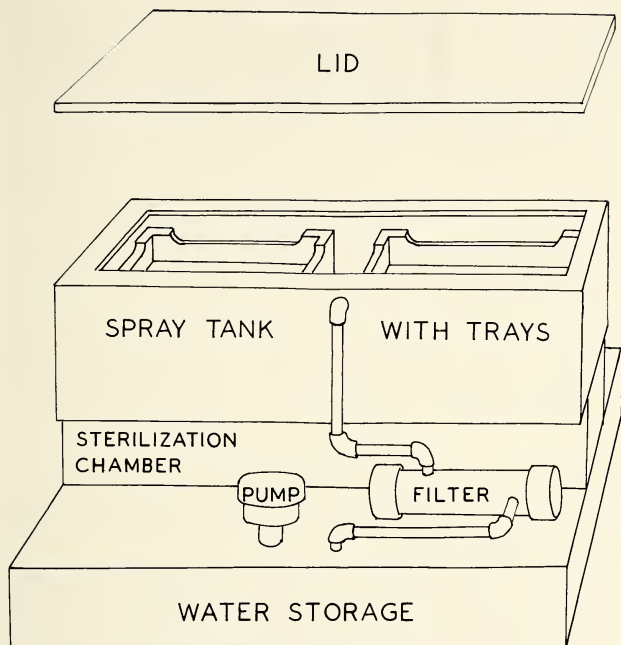


Fig. 1. Portable spray unit.

been newly caught in the Indian River north of the St. Lucie Inlet, served as test animals. In the second test, 40 adult lobsters were obtained from commercial sources at Key Largo, Florida. The spray unit was installed on the pickup truck and temperatures were not controlled, ranging between 15.6 C (60 F) and 22.2 C (72 F). In both tests the unit was checked twice daily and dead lobsters were removed.

RESULTS AND DISCUSSION

Packing Material Results. In the first test (Table 1), all lobsters held at 4.4 C (40 F) were dead within 23 hours. Those held

TABLE 3

Number of lobsters surviving in burlap packing at ambient temperatures.
(Packing Test Nos. 3, 4, & 5)

	Date	4-19-67	4-20-67	4-21-67	
	Time of check	8:00 PM	4:00 PM	8:00 AM	
	Hours (rounded)		20	36	
	21.7 C (71 F)-				
#3	28.3 C (83 F)	10	10	3	
	Date	8-22-67	8-23-67	8-24-67	
	Time of check	8:00 PM	5:00 PM	8:00 AM	
	Hours (rounded)		21	36	
	18.3 C (65 F)-				
#4	23.9 C (75 F)	12	12	11	
	Date	9-20-67	9-21-67	9-21-67	9-22-67
	Time of check	Noon	8:00 AM	4:30 PM	8:00 AM
	Hours (rounded)		20	29	44
	17.8 C (64 F)-				
#5	24.4 C (76 F)	18	12	7	3

at this temperature but with no packing or with burlap packing were dead within 7 hours.

The 10.0 C (50 F) temperature gave somewhat better survival. Two of the 4 lobsters with no packing and 2 with burlap packing lived over 23 hours. The 4 lobsters with no packing were dead within 31 hours, while 2 of those in burlap survived for 48 hours and one was still alive after 3 days. Polyurethane foam yielded 100 per cent survival through 31 hours, but only one lived until the end of the test. All 4 lobsters packed in sargassum lived for 56 hours and 3 were alive after 3 days.

The best results were obtained at temperatures between, 7.2 C (45 F) through 21.1 C (70 F). At these temperatures, all of those in the containers with no packing material lived for 23 hours, and 3 survived 31 hours. Only one was alive after 56 hours and none survived the test. All of those packed in burlap lived throughout the experiment. Polyurethane foam packing yielded 100 per cent survival for 48 hours, 75 per cent for 56 hours and 50 per cent were still alive when the test terminated. In sargassum weed packing, all 4 lobsters lived through 31 hours, 3 through 48 hours, 2 for 56

hours, and one survived the test. Results of the first test are given in Table 1.

During the second test (Table 2) survival was again poorest at 4.4 C (40 F). Lobsters with no packing were all dead within 6 hours. Three of the 4 in burlap were dead within 6 hours and the remaining one died sometime after the 23rd hour. In polyurethane foam, 50 per cent survived 6 hours but all were dead by the end of 23 hours. Of the 3 test lobsters packed in sargassum, all survived for 23 hours and one for 30 hours.

Once again, survival at 10.0 C (50 F) exceeded that at 4.4 C (40 F). Three of the 4 lobsters with no packing lived 6 hours, 2 were alive after 23 hours, and one after 30 hours, but all were dead by 47 hours. In burlap packing, 100 per cent lived through 6 hours but only one lived through 30 hours and it was dead by 47 hours. Those in polyurethane, as well as those in sargassum, lived for 6 hours, 3 of those in polyurethane and 2 of those in sargassum were alive for 30 hours, and one in polyurethane lived through 47 hours. None in the sargassum lived for 47 hours.

Survival at room temperature, 18.3 C (65 F) through 29.4 C (85 F), was once again better than at low temperatures. All lobsters with no packing survived 6 hours, 2 for 23 hours, and all were dead by 30 hours. All those in burlap packing lived through 6 hours and 3 survived for 30 hours. Only 50 per cent of those in polyurethane lived 6 hours but these remained alive for 30 hours, and one was alive after 47 hours. In sargassum packing, all 4 survived 30 hours and 2 for 47 hours, but none survived 55 hours.

The favorable results obtained with burlap packing at room temperatures prompted 3 more trials using this method, but the lobsters were to be held only 36 hours. The erratic results of these three tests do not appear dependent on temperature variations (Table 3). With temperatures of 21.7 C (71 F) through 28.3 C (83 F) the 10 lobsters lived for 20 hours but only 3 survived for 36 hours. When the temperatures were 18.3 C (65 F) through 23.9 C (75 F), all 12 lobsters lived for 21 hours and 11 survived until the test terminated at 36 hours. At temperatures of 17.8 C (64 F) through 24.4 C (76 F) 12 of the 18 lived for 20 hours, 7 for 28 hours, and 3 were still alive at the final checking.

Spray Unit Results. During the first experiment with the portable spray unit in the laboratory, where temperatures were from

24.4 C (76 F)-31.1 C (88 F), all 40 lobsters lived 17 hours but 3 (7.5 per cent) had died by the end of 24 hours. After 65 hours an additional 2 (5 per cent) had died. By the end of the third day (72 hours) another one (2.5 per cent) was dead and one (2.5 per cent) more was dead after 89 hours. No more died until the beginning of the sixth day, by which time 2 (5 per cent) more were dead. The remaining 31 lived through the experiment, giving a survival rate of 77.5 per cent for 7 days. Three of the 9 dead lobsters were found in the process of molting and this may have affected their survival.

In the second test, 15.6 C (60 F)-22.2 C (72 F), with the spray unit installed on the pickup truck, 4 (10 per cent) were dead at 24 hours, with 3 (7.5 per cent) having failed to live for 15 hours. An additional 2 (5 per cent) died before the end of 48 hours. The greatest mortality 9 (22.5 per cent) occurred between 48 and 63 hours. Following the 72nd hour and before the 87th hour, another 6 (15 per cent) died. Four others (10 per cent) died during the time between 96 and 111 hours. Another 3 (7.5 per cent) were dead before the end of the fifth day (120 hours). At the start of the seventh day, one (2.5 per cent) more was dead and the remaining 10 (25 per cent) lived for the full 7 days (168 hours). The results of the two tests with the portable spray unit are given in Table 4.

SUMMARY

Polyurethane foam, sargassum, and burlap bags were wetted with seawater and tested as packing material for live Florida spiny lobsters under varying temperature conditions. Lobster survival in each of these materials was compared with survival of control lobsters held without packing materials. Seawater-wetted burlap bag packing at room temperature gave the best results. Average survival in five tests was approximately 85 per cent for 20-23 hours and 58 per cent for 29-36 hours. Consequently, shipment of live, healthy lobsters under these conditions appears feasible if delivery can be assured within 24 hours and temperature extremes can be avoided.

A system using filtered, sterilized seawater sprayed over live lobsters gave good survival for a minimum of two days and in one experiment 77.5 per cent of the lobsters were in good condition

TABLE 4
Number of lobsters surviving in a self-contained, portable spray unit

		Test No. 1, with unit in an air-conditioned laboratory									
Date	5-31-68	6-1-68	6-2-68	6-3-68	6-4-68	6-5-68	6-6-68	6-7-68			
Time of check	3:00 PM	3:30 PM	3:30 PM	3:30 PM	3:00 PM	4:30 PM	3:30 PM	3:00 PM	3:00 PM	3:00 PM	3:00 PM
Hours (rounded)	25	49	73	96	122	145	168				
24.4 C (76 F)—											
31.1 C (88 F)	40	37	34	33	33	31	31				
		Test No. 2, with unit in pick-up truck									
Date	1-20-69	1-21-69	1-22-69	1-23-69	1-24-69	1-25-69	1-26-69	1-27-69			
Time of check	5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM
Hours (rounded)	24	48	72	96	120	144	168				
15.6 C (60 F)—											
22.2 C (72 F)	40	36	34	24	18	11	11	10			

after one week. This method appears to have possibilities for holding and surface shipment of Florida lobsters.

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